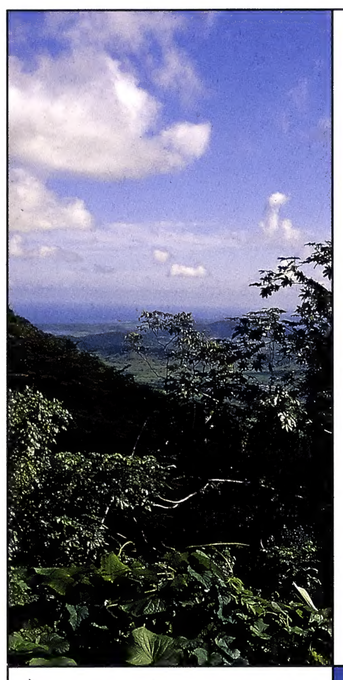
# The Rubiaceae Family

## Research at the Missouri Botanical Garden



**The Rubiaceae, or Coffee, family is one of the world's largest and most diverse dicotyledenous families of angiosperms, or flowering plants.** It numbers about 10,000 species in about 650 genera, represented by shrubs, small trees, herbs, lianas, and a small number of epiphytes and semiaquatics. **Distribution—Tropics vs. Temperate: Rubiaceae are found worldwide. Most temperate Rubiaceae are herbs, but the family is primarily tropical,** where Rubiaceae represent 10% of non-orchid species, **forming the dominant mid-story componet of most Neotropical forests** and a major component of Old World tropics as well. **Worldwide, biodiversity is greatest in the tropics. Two-thirds of all flowering plants—about 170,000 species—occur only there; many are still unknown scientifically and are in danger of extinction. MBG has one of the world's leading research programs in tropical botany.** [CMT]

**Habit—Shrubs and Trees: Most Rubiaceae are shrubs or small trees.** In a unique feature that distinguishes the family even without flowers or fruit, the usual taxonomic characters for identification, **Rubiaceae are characterized by opposite simple leaves with the stipules interpetiolar: united across the stem between the leaves.** *Pentagonia tinajita* **[U]*** displays large stipules; it ranges from Costa Rica to Panama. [CMT]

**Classification—Subfamilies:** Diversity within the Rubiaceae has made classification controversial. **Evolutionary relationships among plants are often obscure because knowledge is lacking.** The widely used system by Elmar Robbrecht of Belgium divides the Rubiaceae into **44 tribes in 4 subfamilies: Cinchonoideae, Ixoroideae, Antirheoideae, and Rubioideae,** which is by far the largest group and includes the common Missouri wildflower *Hedyotis caerulea,* or bluets **[R].** [KY]

**Habit—Shrubs and Trees: Rubiaceae species reach maximum density in the Amazon basin where species such as** *Pentagonia gigantifolia* **[U] comprise 3-5% of the woody plants** according to MBG explorer Alwyn Gentry. In the tropics, sharp differences between zones of vegetation allow many species to occur together in a very small area. [AG]

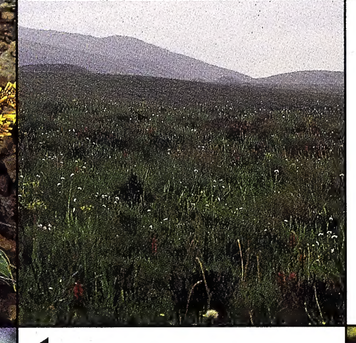
**Habit—Annual: Less than 3% of Rubiaceae species are annuals.** Annuals flower and produce seeds in one growing season; they are common in deserts where water is limiting. *Cruckshanksia pumila* [R] is an annual found in the Chilean Atacama desert; Charlotte Taylor, MBG, coordinates the Flora of Chile project. **MBG administers and/or collaborates in 21 floristic projects worldwide**, including floras of North America, China, Mesoamerica, Madagascar, and much of South America and Africa. **Floras are complete scientific descriptions of all the plants of a selected region.** [CMT]



**Habitats—Ecosystem Reserves:** Rubiaceae are common in the Guánica Biosphere Reserve in the U.S. Commonwealth of Puerto Rico, **one of the world's few remaining naturally seasonally dry tropical forests. Dry tropical areas, like wetlands, are endangered worldwide by agricultural conversion. Since 1974 UNESCO has established 312 biosphere reserves in 81 countries to preserve threatened ecosystems.** [CMT]

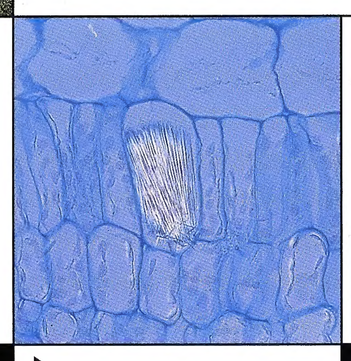
**Habit—Pyrrhophytes: Herbaceous plants adapted to fire that maintain their perennial stems underground.** *Palicourea rigida* **[R]** is one of very few fire-adapted South American species; many African Rubiaceae are pyrrhophytes. [TC]

**MBG—Africa: MBG is the center for African botany in the U.S. Programs include collecting plants in Africa for screening by the National Cancer Institute for potential pharmaceutical agents.** Often ethnobotanical information from indigenous people leads to modern medical applications; **40% of all drugs in the U.S. are derived from natural sources.** The herbaceous genus *Pentas* **[R]** is native to eastern tropical Africa (far right). [CMT]



**Classification—Fruits: Rubiaceae are classified primarily by using their fruit, in addition to other features.** Dry capsules often have **wind-dispersed** seeds; fleshy fruits containing nutrient-rich seeds are often **animal-dispersed,** particularly by birds. The yellow branches of *Palicourea* **[R]** are an infructescence, or group of fruits, that help attract birds that eat the fruits. [AG]

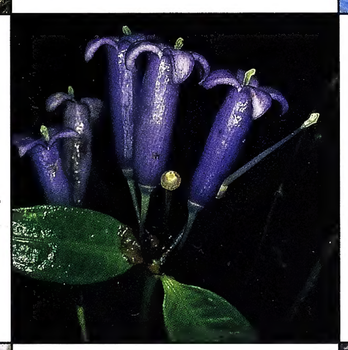
**MBG Research—International Collaboration: Preservation of biological diversity depends on collaboration.** In 1992, 525 scientists visited MBG, 141 from foreign countries. The MBG Graduate Studies Program trains about 20 botanists per year, 13 from abroad in 1992. *Mitchella repens* is a typical example of how **plant species range across national boundaries; conservation strategies must cooperate internationally as well.** [KY]



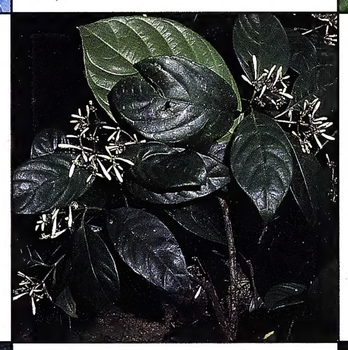
**Chemical Defenses: The presence of calcium oxalate crystals, $CaC_2O_4 \cdot H_2O$, is a key characteristic of the Rubiaceae's largest subfamily, Rubioideae [R].** The sharp crystals are believed to be a defense against insects and other herbivores. **Alkaloid compounds are common in the Rubiaceae,** including quinine found in *Cinchona* **[C]** and the caffeine in *Coffea* **[I]** which is related to non-Rubiaceae alkaloids in chocolate and tobacco. [CP]

**Flowers—Distylous:** Many Rubiaceae species are distylous, with individual plants having one of two floral types, long-styled or short-styled, to insure out-crossing. **This unusual floral adaptation increases genetic variation,** as each floral type can only successfully pollinate flowers of the other type. **Genetic diversity in local populations provides the raw material that biotechnology is based upon.** *Morinda citrifolia* **[R]** is a distylous shrub found on tropical beaches worldwide. [TC]

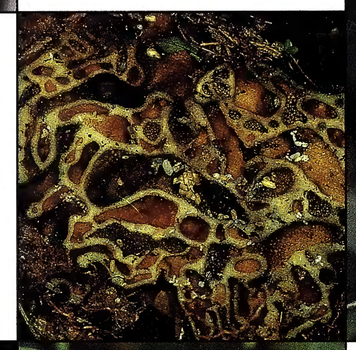
**Plant/Animal Interaction—Pollination:** Brightly colored inflorescences, or flower groups, that attract pollinators and **colored tubular flowers adapted for bird or butterfly pollination are abundant in the Rubiaceae.** The hummingbird-pollinated species *Faramea killipii* **[R],** with its bright purple tubular corollas, is **endemic, or restricted in habitat and geographic range,** to the Andes of Colombia and Venezuela. [CP]



**Diversity—Speciation: *Psychotria,* with about 2000 species, is by far the largest genus of Rubiaceae and ranks among the largest genera of plants.** *Psychotria eurycarpa* **[R]** is from Costa Rica, one of the first modern countries to establish a national biological inventory. MBG staff in Costa Rica are collaborating with the National Museum of Natural History and INBio, the National Biodiversity Institute, to develop a countrywide identification manual, in Spanish. [BEH]

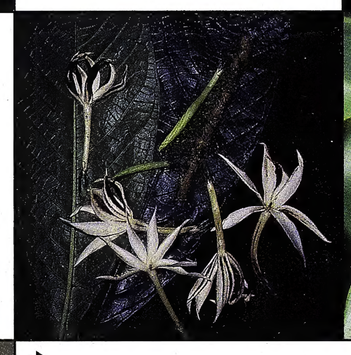


**Plant/Animal Interactions—Symbiosis: Some Rubiaceae have morphological structures in their stems or leaves which house ants or mites.** The ants and mites defend the plants from herbivores and insect predators, and in some cases provide nutrients through the detritus accumulating in their nests. *Hydnophytum* sp. **[R],** native to Indo-Malaysia, shelters ants in its interior. [CP]

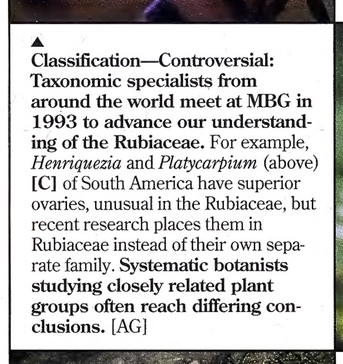


**Conservation—Extinction: Habitat Conversion. The Center for Plant Conservation at MBG coordinates efforts at 25 botanical institutions in the U.S. to create integrated conservation plans for threatened plants.** *Palicourea alpina* **[R]** in Puerto Rico is endangered by construction of communication towers in mountaintop forests. **Of the 700 U.S. plants facing imminent extinction, 73% are found in Hawaii, California, Texas, Florida and Puerto Rico.** [CMT]

**New to science: MBG scientists described 259 new species of plants in 1991.** *Randia mira* **[I],** an unusual rain forest tree of Costa Rica and Panama, is **cauliflorous,** bearing its hawkmoth-pollinated flowers on the lower trunk, far below the leaves. **This plant was first collected by scientists working on MBG's *Flora of Panama* project, 1943-1986, and described by MBG scientist John Dwyer.** [BEH]



**Classification—Computerization: Generic relationships within the Rubiaceae are not well understood.** *Schradera* **[R],** a neotropical genus that has been placed in different tribes, is an example. **MBG is a world leader in developing mechanisms for sharing information** critical to increasing our knowledge. **TROPICOS, the database system developed at MBG, provides integrated plant information to botanists, conservationists and land use experts around the world.** [TC]

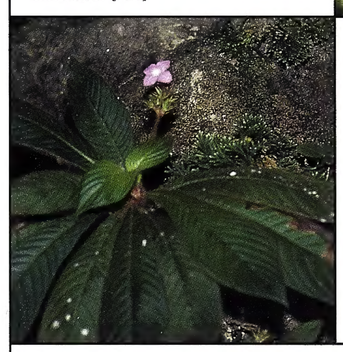


**Classification—Controversial: Taxonomic specialists from around the world meet at MBG in 1993 to advance our understanding of the Rubiaceae.** For example, *Henriquezia* and *Platycarpium* (above) **[C]** of South America have superior ovaries, unusual in the Rubiaceae, but recent research places them in Rubiaceae instead of their own separate family. **Systematic botanists studying closely related plant groups often reach differing conclusions.** [AG]

**Habit—Lianas: Climbing plants form 20% of tropical plant communities. About 500 Rubiaceae species are lianas;** *Chiococca alba* **[A]** is a common vine of the American tropics. **Two-thirds of all species live only in the tropics; scientists have discovered and named only about one in six. Deforestation, driven by population growth, poverty, and lack of knowledge about sustainable land use, is eradicating species faster than they can be discovered and understood.** [CMT]

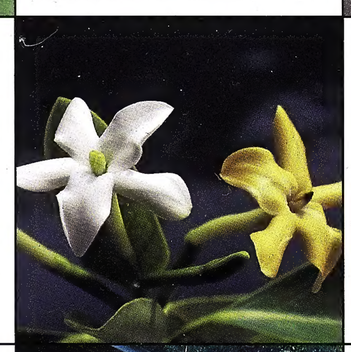
**Flowers—Pollination Systems: Most flowers of the Rubiaceae are pollinated by animals, usually insects or birds.** Many Rubiaceae have a few flowers with one very large calyx lobe that attracts pollinators to the flower. On *Warszewiczia coccinea* **[C],** a common tree of the American tropics, these calyx lobes are particularly showy. [WB]

**Many Rubiaceae species have small white flowers that attract small insects.** *Arcytophyllum* **[R]** is a typical example; it is a low shrub common in *páramos,* the treeless alpine vegetation of the high Andes of South America. Recent research at the International Center for Tropical Ecology at U.M. St. Louis, an MBG research affiliate, indicates that **current deforestation rates in tropical forests, together with the decline of many tropical bird species, jeopardize the delicate ecological balance between Rubiaceae and the birds that disperse their seeds.** [AG]

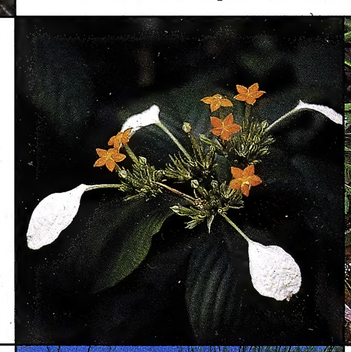


**Conservation—Endemism and Extinction:** Many Rubiaceae species, such as *Cosmibuena grandiflora* **[C],** have a wide range. [AG]

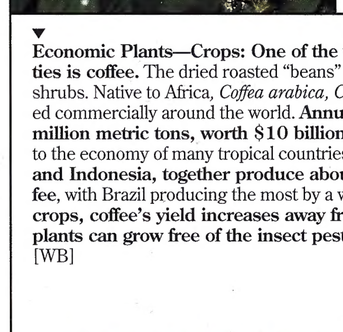
Others, such as *Steyermarkia guatemalensis* **[C],** are highly **endemic, restricted to a small geographic area.** The plant is named for the late Julian Steyermark of MBG who still holds the Guiness World Record for collecting 132,223 specimens. **Areas with many endemic species are priority areas for conservation.** [BEH]



**Horticulture—Ornamentals: Many Rubiaceae shrubs are cultivated for their beautiful and often fragrant flowers.** *Mussaenda* cultivars **[C]** (right) are popular in tropical areas, but **the horticultural star of the family is the gardenia,** *Gardenia augusta* **[I],** with its own society of devotees and enormous annual commercial sales to both landscape gardeners and florists. [WB]

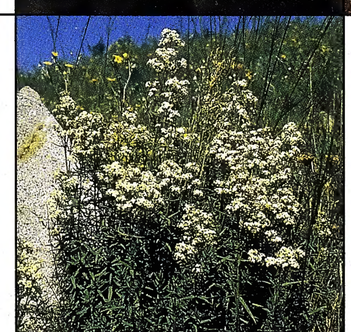


**Conservation—Exploration:** Many species previously thought to be rare, such as *Wittmackanthus stanleyanus* **[C]** of northern South America, are being found in greater numbers as botanists explore new areas. **Exploration and collection has increased scientific knowledge. MBG conducts field exploration in more than 30 countries; in 1992, the MBG herbarium added 189,750 specimens to an over-all total of over 4 million.** [AG]

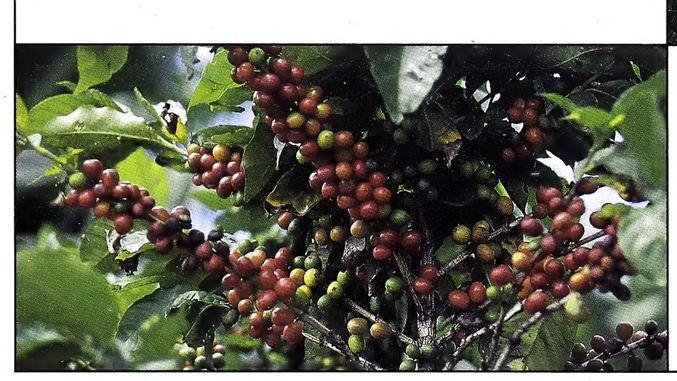


**Economic Plants—Crops: One of the world's most important commodities is coffee.** The dried roasted "beans" are actually seeds of tropical *Coffea* **[I]** shrubs. Native to Africa, *Coffea arabica, C. liberica,* and their hybrids are cultivated commercially around the world. **Annual world coffee production is over 6 million metric tons, worth $10 billion in export earnings.** This crop is vital to the economy of many tropical countries. Three countries, **Brazil, Colombia and Indonesia, together produce about 40% of the world's supply of coffee,** with Brazil producing the most by a wide margin. **As with many tropical crops, coffee's yield increases away from its center of origin, where the plants can grow free of the insect pests that have co-evolved with them.** [WB]

**Conservation—Botanical Gardens:** As our natural ecosystems become increasingly threatened with destruction, **botanical gardens have an increasingly important role to play in conservation and education.** CPC Participating Institutions, for example, are uniquely equipped to preserve and propagate endangered native species and reintroduce them to the wild, as well as showcasing ornamental plants such as *Ixora coccinea* **[I].** [TC]



**International Conservation—Cooperation: Plants support the fundamental architecture of life on our planet; preserving biodiversity must become an international ethic. The survival of thousands of species, the future functioning of the world's ecosystems, and global population stabilization depend on integrating sustainable economic development with conservation and involving local residents and indigenous peoples in these actions.** MBG collaborates with local institutions in each country where it conducts research, providing technical assistance, helping to find funding, establishing relationships with the worldwide scientific community, training local botanists in the field and at MBG, and helping to build infrastructure. **In the next 41 years world population is expected to double. Present population uses or wastes 40% of Earth's net total terrestrial photosynthetic productivity; botanical research helps to provide the scientific basis for conservation priorities and action.** [CMT]



**Economic Plants—Pharmaceuticals: *Cinchona calisaya, C. pubescens,* and *C. officinalis* [C] are the source of quinine, a treatment for malaria which allowed colonization in previously uninhabitable tropical regions, causing increased habitat conversion for human use.** New strains of malaria are becoming increasingly resistant to the widely used synthetic versions of the drug, and today malaria kills 2 million people annually and causes 100 million acute cases. [CP]

**Economic Plants—Ethnobotany:** The roots of *Rubia tinctorum* **[R],** a Mediterranean shrub from which the family takes its name, long provided Europeans with a red **textile dye.** *Galium boreale* **[R]** has a sweet odor when dried and was used by medieval Europeans as **bedding material. Ethnobotanical information from indigenous peoples provides clues for developing underutilized plants: currently only 20 species provide more that 80% of the world food consumption.** [CP]

*The 1993 Rubiaceae symposium at MBG is dedicated to John Dwyer, MBG and St. Louis University, a specialist in the Rubiaceae. This poster is dedicated to the spirit of international collaboration, exemplified by all of the individuals who contributed their photographs, and by David H. Lorence, Elmar Robbrecht, Ihsan Al-Shehbaz, Victoria L. Sork, Bette A. Loiselle, and Dr. E.L. Pool, who kindly gave their assistance.*

**Research at the Missouri Botanical Garden**

Fifty-five Ph.D.-level scientists, ten of whom live in other countries, technical staff, and graduate students devote their energies to collecting and studying plants and to exploration of selected regions. These efforts are concentrated in Central America, South America, subsaharan Africa, Madagascar, China and North America. MBG is headquarters to the Floras of China and North America and the Center for Plant Conservation.

Individual MBG scientists are specialists in the plants of particular regions or in the classification of certain plant families, such as the economically important grass, legume and nightshade families. Their research is carried out in collaboration with scientists of the countries in which they are actively working. Together they are contributing to a common knowledge of the plants that sustain us all, with a view toward conserving and properly utilizing them.

**Photo Credits / Key to Symbols**

***Subfamily:**
[A] = Antirheoideae
[C] = Cinchonoideae
[I] = Ixoroideae
[R] = Rubioideae
[U] = Subfamily not classified at present

[AG] Alwyn H. Gentry, MBG
[BEH] Barry E. Hammel, MBG
[CP] Christian Puff, Univ. of Vienna
[CMT] Charlotte M. Taylor, MBG
[KY] Kay Yatskievych, MBG
[TC] Thomas B. Croat, MBG
[WB] William Burger, Field Museum of Natural History

MBG = Missouri Botanical Garden
CPC = Center for Plant Conservation

This poster was compiled and written by Tamra E. Raven, Nancy R. Morin, Charlotte M. Taylor, and Susan W. Caine.

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